Remarks

The present amendment responds to the Official Action dated May 21, 2007. A petition for a one month extension of time and authorization to charge our Deposit Account No. 50-1058 the one month extension fee of $120 accompany this amendment. The Official Action rejected claim 1 under 35 U.S.C. 112, second paragraph, as indefinite. Claims 1-5 were rejected under 35 U.S.C. 103(a) based on McCandless U.S. Patent No. 5,626,294 (McCandless). These grounds of rejection are addressed below following a brief discussion of the present invention to provide context. Claims 1-5 have been amended to be more clear and distinct. Claims 1-5 are presently pending.

The Present Invention

The claims as presently amended find exemplary support in the specification as follows. Claim 1 as presently amended finds support in the disclosure at p. 12, lines 11-22, p. 12, line 23-p.13, line 8, p. 6, line 21-p.7, line 11, p. 13, line 24-p. 14, line 9, p. 14, lines 10-20 and p. 14, line 21-p. 15, line 6, and Figs. 5 and 6.

More specifically, for ease of reference the descriptions in the respective paragraphs are cited below with underlining specifically indicating support for the amendment.

Page 12, lines 11-22

The needle valve 2 has a substantially cylindrical shape, and the tip part 21 has a substantially right circular cone shape. The shape of the tip part 21 is set by a center diameter L3 for regulating a minimum flow path area of the fuel injection nozzle 1 at full lift, a seat diameter

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Remarks

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The Present Invention

The claims as presently amended find exemplary support in the specification as follows. Claim 1 as presently amended finds support in the disclosure at p. 12, lines 11-22, p. 12, line 23-p.13, line 8, p. 6, line 21-p.7, line 11, p. 13, line 24-p. 14, line 9, p. 14, lines 10-20 and p. 14, line 21-p. 15, line 6, and Figs. 5 and 6.

More specifically, for ease of reference the descriptions in the respective paragraphs are cited below with underlining specifically indicating support for the amendment.

Page 12, lines 11-22

The needle valve 2 has a substantially cylindrical shape, and the tip part 21 has a substantially right circular cone shape. The shape of the tip part 21 is set by a center diameter L3 for regulating a minimum flow path area of the fuel injection nozzle 1 at full lift, a seat diameter L2 of a seat part 211 coming in contact with a valve seat part 33 and blocking communication

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with the fuel injection hole 31, and a shaft diameter L1, and a tip part angle is abut 92 degrees. The center diameter L3 is set to ϕ2.5 mm, the seat diameter L2 is set to ϕ3.0 mm, and the shaft diameter L1 is set to ϕ3.25 mm. The ratio of the center diameter L3 and the seat diameter L2 is L3/L2 = 2.5 mm/3.0 mm = about 0.833, and the ratio of the seat diameter L2 and the shaft diameter L1 is L2/L1 = 3.0 mm/3.25 mm = about 0.92.

Page 12, line 23 - Page 13, line 8

In the fuel injection nozzle 1 of a valve closed state, the outer peripheral surface of the tip part 21 of the needle valve 2 urged in a state where the injection start pressure is regulated by the spring force of the nozzle spring 52 is seated on the valve seat part 33 of the nozzle body 3 as an inlet of the fuel injection hole 31 as shown in the drawing. Then, the needle valve 2 is lifted by the pressure of a predetermined amount of high pressure DME fuel sent from an injection pump and the like, so that the tip part 21 of the needle valve 2 is separated from the valve seat part 33 to form a valve open state, and the DME fuel is sent from between the tip part 21 of the needle valve 2 and the valve seat part 33 to the fuel injection hole 31.

Page 6, line 21 - Page.7, line 11

The ratio L3/L2 of the center diameter and the seat diameter, which is set to about 0.35 to 0.6 in the conventional diesel engine using light oil as fuel, is set to 0.70 or higher. That is, the difference between the center diameter and the seat diameter becomes small, and as the value of the center diameter/the seat diameter approaches 1, the size of the center diameter approaches the seat diameter, and the interval between the seat part coming in contact with the valve seat part and the center diameter becomes short. Accordingly, since the center diameter inevitably

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becomes larger than the convention needle valve, the position of the center diameter in the valve seat part in the state where the seat part is seated on the valve seat part is positioned at an inner peripheral surface of the valve seat part having an inner diameter larger than a conventional one. Accordingly, the inner diameter of the inner peripheral surface of the valve seat part, together with the center diameter, constituting the minimum flow path area at full lift becomes large, and by that, the minimum flow path area regulated by the center diameter at full lift can be increased.

Page 13, line 24 - page 14, line 9

The needle valve 2 is moved in the direction of the arrow denoted by reference character B and is lifted to a position of a maximum lift amount D, and at a time point when a full lift state occurs, an area of a portion where an interval between the tip part 21 of the needle valve 2 and the valve seat part 33 becomes minimum is a minimum flow path area d. Accordingly, a flow path area formed of the minimum flow path area d between the outer peripheral surface of the tip part 21 and the valve seat part 33 is a minimum flow path area. Besides, a maximum value of the fuel injection amount is determined by the total injection hole area of the fuel injection hole 31. Incidentally, in this embodiment, the maximum lift amount D at full lift of the fuel injection nozzle 1 is set to about 0.25 mm.

Page 14, lines 10-20

Here, as compared with the case of the fuel injection nozzle 1 of the diesel engine using light oil as fuel shown in Fig. 11, first, the size of the fuel injection hole 31 of the nozzle body 3 of the fuel injection nozzle 1 according to the invention is formed to be larger, and by that, the total injection hole area is set to become approximately twice as large. This is because, as

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described before, in order to obtain the same engine output as the light oil fuel by using the DME fuel, a fuel injection amount larger than the light oil fuel becomes necessary. Accordingly, by setting the total injection hole area of the fuel injection hole 31 to be larger than that in the light oil fuel, the engine output comparable to the light oil fuel can be obtained by the DME fuel.

Page 14, line 21-page 15, line 16

Besides, in the tip part 21 of the needle valve 2, the ratio L3/L2 of the center diameter L3 and the seat diameter L2 is set to be as large as about 0.833 in the fuel injection nozzle 1 of the invention, while it is set to 0.50 in the conventional fuel injection nozzle 1 of the diesel engine using light oil as fuel. Besides, the ratio L2/L1 of the seat diameter L2 and the shaft diameter L1 is set to be as large as about 0.92 in the fuel injection nozzle 1 of the invention, while it is set to about 0.68 in the conventional fuel injection nozzle 1 of the diesel engine using light oil as fuel. By that, the minimum flow path area d of the fuel injection nozzle 1 of the invention at full lift is approximately twice as large as that of the conventional fuel injection nozzle 1 of the diesel engine using light oil as fuel.

In view of the above, the amendment of claim 1 is clearly supported by the disclosure in the specification and drawings as originally filed.

Claim 2 as presently amended finds support at page 6, line 21-page 7, line 11 and page 7, line 22-page 8, line 12 of the specification.

The former paragraph is set forth above, and is not repeated. However, the description in the latter paragraph, page 7, line 22-page 8, line 12, is cited below for ease of reference. The underlining specifically indicates exemplary support for the amendment.

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Page 7, line 22 - page 8, line 12

The ratio L2/L1 of the shaft diameter and the seat diameter, which is set to about 0.60 to 0.70 in the conventional diesel engine using light oil as fuel, is set to 0.85 or higher in the invention. That is, the difference between the shaft diameter and the seat diameter becomes small, and as the value of the seat diameter/the shaft diameter approaches 1, the size of the seat diameter approaches the shaft diameter. Accordingly, the seat diameter becomes larger than that of the conventional needle valve, and in proportion to that, the center diameter also becomes large inevitably. Accordingly, the position of the center diameter in the valve seat part and in the state where the seat part is seated on the valve seat part is positioned at an inner peripheral surface of the valve seat part having a further large inner diameter. Accordingly, the inner diameter of the inner peripheral surface of the valve seat part, together with the center diameter, constituting the minimum flow path area at full lift becomes further large, and by that, the minimum flow area regulated by the center diameter at full lift can be further increased.

In view of the above, the amendment in the new claim 2 is clearly supported by the disclosure in the specification and drawings as originally filed.

Claim 3 as presently amended finds support in the disclosure at p. 15, lines 7-18. This text is set forth below for ease of reference. The underlining specifically indicates the support for the amendment.

Page 15, lines 7-18

As stated above, in order to obtain the fuel injection amount necessary for the DME fuel, the ratio L3/L2 of the center diameter L3 and the seat diameter L2 is made 0.7 or higher and

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about 0.833 in this embodiment, and the ratio of L2/L1 of the seat diameter L2 and the shaft diameter L1 is made 0.85 or higher and about 0.92 in this embodiment, so that the minimum flow path area d at full lift can be made the area approximately twice as large. Besides, by setting the hole diameter of each of the fuel injection holes 31 such that the total injection hole area becomes approximately twice as large, the fuel injection amount of the fuel injection nozzle 1 can be set to be approximately twice as large. By that, it is possible to obtain the fuel injection amount of the DME fuel which enables the engine output comparable to the light oil to be obtained.

In view of the above, the amendment to claim 3 is clearly supported by the disclosure in the specification and drawings as originally filed.

Returning to claim 1, one problem to be solved by the present invention is described at page 3, line 11-page 3, line 4 and page 4, lines 6-9 of the specification which are quoted below for ease of reference.

Page 3, line 11-page 4, line 4

However, as described above, although DME has many merits as the fuel of the diesel engine, as compared with the light oil, energy obtained from a same amount of fuel is low, and accordingly, when the amount of fuel injection is the same as that in the case of the light oil, an engine output becomes lower than that in the case of the light oil. Thus, a conventional diesel engine using light oil as fuel can not be used directly as a diesel engine using DME as fuel. In the case where a diesel engine using DME as fuel is designed and manufactured from the first, it is sufficient if the amount of fuel injection is set so that a specified engine output can be obtained

by the DME fuel. However, in an existing diesel engine vehicle using light oil as fuel, in case the mounted whole diesel engine must be exchanged with a diesel engine of DME fuel, it takes very high cost, labor, and time, and this can not be said to be realistic. Accordingly, even if a diesel engine vehicle of DME fuel is put to practical use, the replacing of existing light oil fuel diesel engine vehicles is not smoothly carried out, and by that, the spread of the diesel engine of DME fuel is much delayed, and there is a fear that measures against the worrying destruction of the environment and global warming are delayed, and the exhaustion of oil resources is hastened. (emphasis added)

Page 4, lines 6 - 9

The invention has been made in view of such circumstances, and its object is to enable an existing diesel engine vehicle of light oil fuel to run as a diesel engine vehicle using DME as fuel without exchanging the whole diesel engine, and at very low cost and easily. (emphasis added)

In view of the above, one problem to be solved or object to be achieved by the present invention is to enable an existing diesel engine of light oil fuel to run as a diesel engine using DME as fuel with an engine output characteristic comparable to diesel fuel, without changing the external shape of a fuel injection nozzle, the shaft diameter of a needle valve 2, and so forth.

Thus, claim 1 may be embodied as follows:

1) the tip part (21), of a substantially right circular cone shape, of the needle valve (2) has a shape set by a center diameter (L3) for defining a minimum flow path area (d) of the fuel flow path defined as a minimum interval between the needle valve (2) at full lift and the valve seat part (33), a seat diameter (L2) of a seat part (211) which is positioned on a root side with

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respect to the center diameter L3 and is for coming in contact with the valve seat part (33) and blocking communication with the fuel injection hole (31), and a shaft diameter (L1) of a needle valve body, and

2) the tip part (21) is shaped such that a size of the center diameter (L3) is made closer to that of the seat diameter (L2) by positioning the center diameter (L3) closer to the seat diameter (L2),

3) to such a degree that an injection amount of the DME fuel which enables an engine output characteristic comparable to light oil fuel to be obtained is attained with the minimum flow path area (d) of the fuel flow path defined by the center diameter (L3) with the needle valve (2) at full lift, according to the total injection hole area of the fuel injection hole (31).

Several functions and effects of the invention according to claim 1 are discussed at page 5, lines 13-17, page 5, line 18-page 6, line 6, page 6, lines 7-15, page 17, lines 4-11 and page 18, lines 5-8 of the specification which are quoted below for ease of reference:

Page 5, lines 3-17

In order to obtain the engine output comparable to the light oil fuel, it is necessary to increase the fuel injection amount with respect to the lift amount of the needle valve. Then, first, the total injection hole area of the fuel injection hole formed in the nozzle body, which is an injection port for injecting the DME fuel into the combustion chamber, is increased. That is, the total injection hole area of the fuel injection hole is made to have such a size that the injection amount of the DME fuel from the fuel injection hole enables the engine output comparable to the light oil fuel to be obtained. By that, the DME fuel whose amount enables the engine output

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comparable to the light oil to be obtained can be injected into the combustion chamber. Incidentally, in order to obtain the engine output comparable to the light oil fuel by using the DME fuel, the fuel injection amount approximately twice as large is required, and therefore, it is necessary that the fuel injection hole with the total injection hole area approximately twice as large or larger is formed the in nozzle body.

Page 5, lines 18-page 6, line 6

The fuel flow path of the DME fuel from the inside of the nozzle body to the fuel injection hole, which is constructed in such a manner that the needle valve is lifted and the tip part of the needle valve is separated from the valve seat part, has the flow path area to enable the engine output characteristic comparable to the light oil fuel with respect to the lift amount of the needle valve to be obtained by using the DME fuel. Thus, in the diesel engine designed to use the light oil as the fuel, the engine output comparable to the light oil fuel can be obtained by using the DME fuel without changing the outer shape of the fuel injection nozzle, the outer diameter of the needle valve and the like. Accordingly, when the fuel injection nozzle of the existing diesel engine designed to use the light oil as the fuel is exchanged for the fuel injection nozzle for DME fuel, the existing diesel engine of the light oil fuel can be directly driven as the diesel engine using DME as fuel.

Page 6, lines 7-15

By this, according to the fuel injection nozzle for DME fuel of the first aspect of the invention, when the fuel injection nozzle of the existing diesel engine designed to use the light oil as the fuel is exchanged for the fuel injection nozzle for DME fuel, the existing diesel engine

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of the light oil fuel can be directly driven as the diesel engine using DME as fuel. Accordingly, the operation and effect that the existing diesel engine vehicle of the light oil fuel can be made to run as the diesel engine vehicle using DME as fuel without exchanging the whole diesel engine, and at very low cost and easily.

Page 17, lines 4-11

In this way, in the diesel engine designed to use light oil as fuel, when only the fuel injection nozzle is changed to the fuel injection nozzle 1 of this invention, the engine output characteristic comparable to the light oil fuel can be obtained by the DME fuel without changing the outer shape of the fuel injection nozzle, the shaft diameter of the needle valve 2, and the like. Thus, the existing diesel engine vehicle of the light oil fuel can be made to run as the diesel engine vehicle using DME as fuel at very low cost and easily.

Page 18, lines 5-8

According to the invention, the existing diesel engine vehicle of the light oil fuel can be made to run as the diesel engine vehicle using DME fuel as fuel without exchanging the whole diesel engine, and at very low cost and easily.

That is, the present invention has the following characteristics:

a) the tip part (21) is shaped such that a size of the center diameter (L3) is made closer to that of the seat diameter (L2) by positioning the center diameter (L3) closer to the seat diameter (L2) (2) given above),

b) to such a degree that an injection amount of the DME fuel which enables an engine output characteristic comparable to light oil fuel to be obtained is attained with the minimum flow path

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area (d) of the fuel flow path defined by the center diameter (L3) with the needle valve (2) at full lift, according to the total injection hole area of the fuel injection hole (31) (3) given above).

By virtue of such characteristics,

an existing diesel engine using light oil as fuel can be driven as a diesel engine using DME as fuel with an engine output characteristic comparable to light oil fuel without changing the external shape of a fuel injection nozzle, the shaft diameter of a needle valve (2), and so forth, by just implementing simple changes such as increasing the total injection hole area of the fuel injection hole (31) of the nozzle body (3) of the fuel injection nozzle for application to the use of DME fuel, and increasing the size of the center diameter (L3) of the tip part (21) of the needle valve (2) by positioning the center diameter (L3) closer to the seat diameter (L2).

Section 112 Rejection

The present amendments have overcome this rejection.

The Art Rejections

As addressed in greater detail below, McCandless does not support the Official Action's reading of it and the rejections based thereupon should be reconsidered and withdrawn. Further, the Applicant does not acquiesce in the analysis of McCandless made by the Official Action and respectfully traverses the Official Action's analysis underlying its rejections. More particularly, McCandless does not support a rejection of the claims as presently amended as discussed in greater detail below.

McCandless generally discloses what the Examiner pointed out, but no more than that. That is, McCandless does not disclose driving a light oil fuel diesel engine on DME fuel. More specifically, McCandless has no disclosure and no suggestion of the object of the present invention, that is, to "drive an existing diesel engine using light oil fuel as a diesel engine using DME as fuel without replacing the entirety of the diesel engine, that is, without designing and manufacturing a diesel engine anew," in order to obtain an engine output comparable to light fuel.

As such, it is not surprising that McCandless lacks a specific means or constitution for achieving the above object, that is, to obtain an output comparable to light fuel by using DME fuel. McCandless does not disclose and does not suggest the characteristic constitutions of the present invention claimed by the claims as presently amended.

There is no disclosure and no suggestion by McCandless of the effect of the present invention, that "an existing diesel engine using light oil as fuel can be driven as a diesel engine using DME as fuel with an engine output characteristic comparable to light oil fuel without changing the external shape of a fuel injection nozzle, the shaft diameter of a needle valve (2), and so forth, by just implementing simple changes such as increasing the total injection hole area of the fuel injection hole (31) of the nozzle body (3) of the fuel injection nozzle for application to the use of DME fuel, and increasing the size of the center diameter (L3) of the tip part (21) of the needle valve (2) by positioning the center diameter (L3) closer to the seat diameter (L2).

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As explained above in detail, the invention according to claim 1 as presently amended is different from McCandless in the problem to be solved, constitution and function and effect, and therefore is not obvious therefrom.

Regarding claim 2, claim 2 may be specifically characterized as follows:

a) the size of the center diameter (L3) is made closer to that of the seat diameter (L2) by positioning the center diameter (L3) closer to the seat diameter (L2), and

b) the size of the seat diameter (L2) is made closer to that of the shaft diameter (L1) by positioning the seat diameter (L2) closer to the shaft diameter (L1),

c) to such a degree, in total, that an injection amount of the DME fuel which enables an engine output characteristic comparable to light oil fuel to be obtained is attained with the minimum flow path area (d) of the fuel flow path defined by the center diameter (L3) with the needle valve (2) at full lift, according to the total injection hole area of the fuel injection hole (31).

The invention as claimed by claim 2, further has: the constitution b) given above, that "... is made closer to ... (omitted) ... by positioning the seat diameter (L2) closer to the shaft diameter (L1)"; and the constitution c) that "to such a degree, in total, that an injection amount of the DME fuel which enables an engine output characteristic comparable to light oil fuel to be obtained is attained ... (omitted) ...," which are neither disclosed nor suggested by McCandless.

Both the center diameter (L3) and the seat diameter (L2) are a part of the tip part (21) of the needle valve (2). Thus, any further change to the position of the seat diameter (L2) as described above is merely a change to the tip part (21) of the needle valve, and can be implemented easily. Implementing a change to position both the center diameter (L3) and the

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seat diameter (L2) "closer to ..." as described above can increase the minimum flow path area (d), so as to obtain the effect of flexibly achieving the object of the present invention, "to enable an existing diesel engine of light oil fuel to run as a diesel engine using DME as fuel with an engine output characteristic comparable to diesel fuel, without changing the external shape of a fuel injection nozzle, the shaft diameter of a needle valve 2, and so forth."

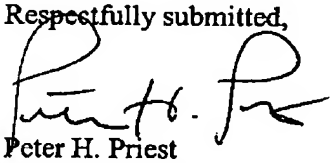
As addressed above, the invention according to claim 2 of the present application is significantly different from McCandless in the problem to be solved, constitution and function and effect, and therefore is considered not obvious therefrom.

On the basis of the patentability of the new claims 1 and 2 explained above, it is considered that claims 3 to 5 also clearly has patentability.

Conclusion

All of the presently pending claims, as amended, appearing to define over the applied references, withdrawal of the present rejection and prompt allowance are requested.

Respectfully submitted,



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